Satellite data sets for climate prediction and services

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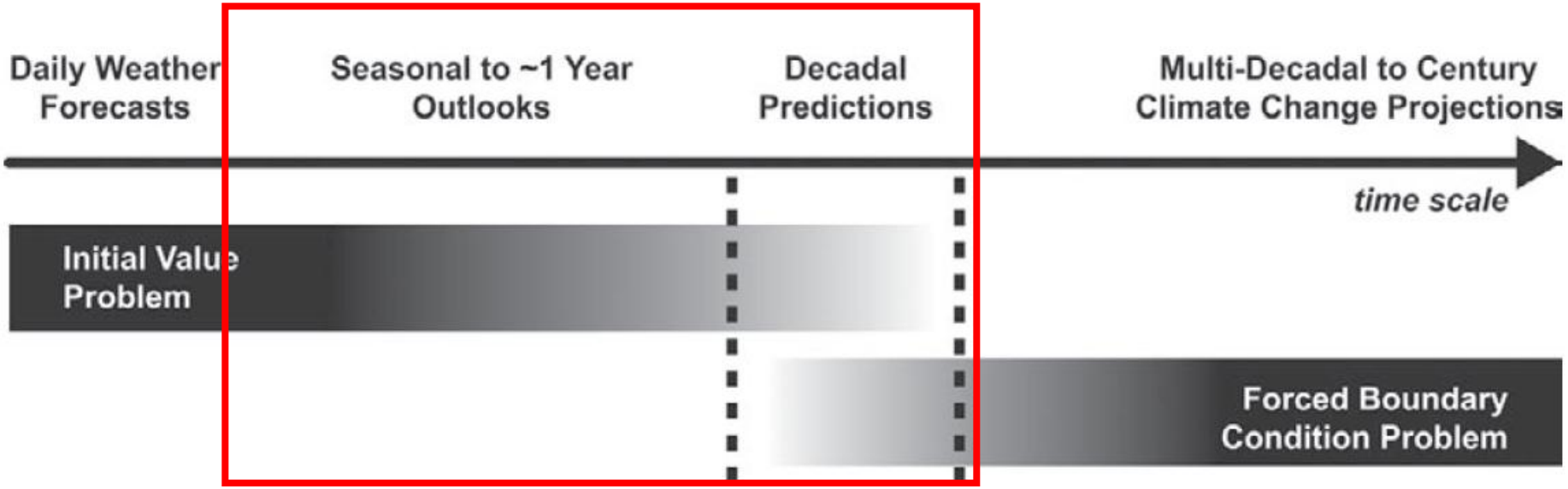
Climate time scales

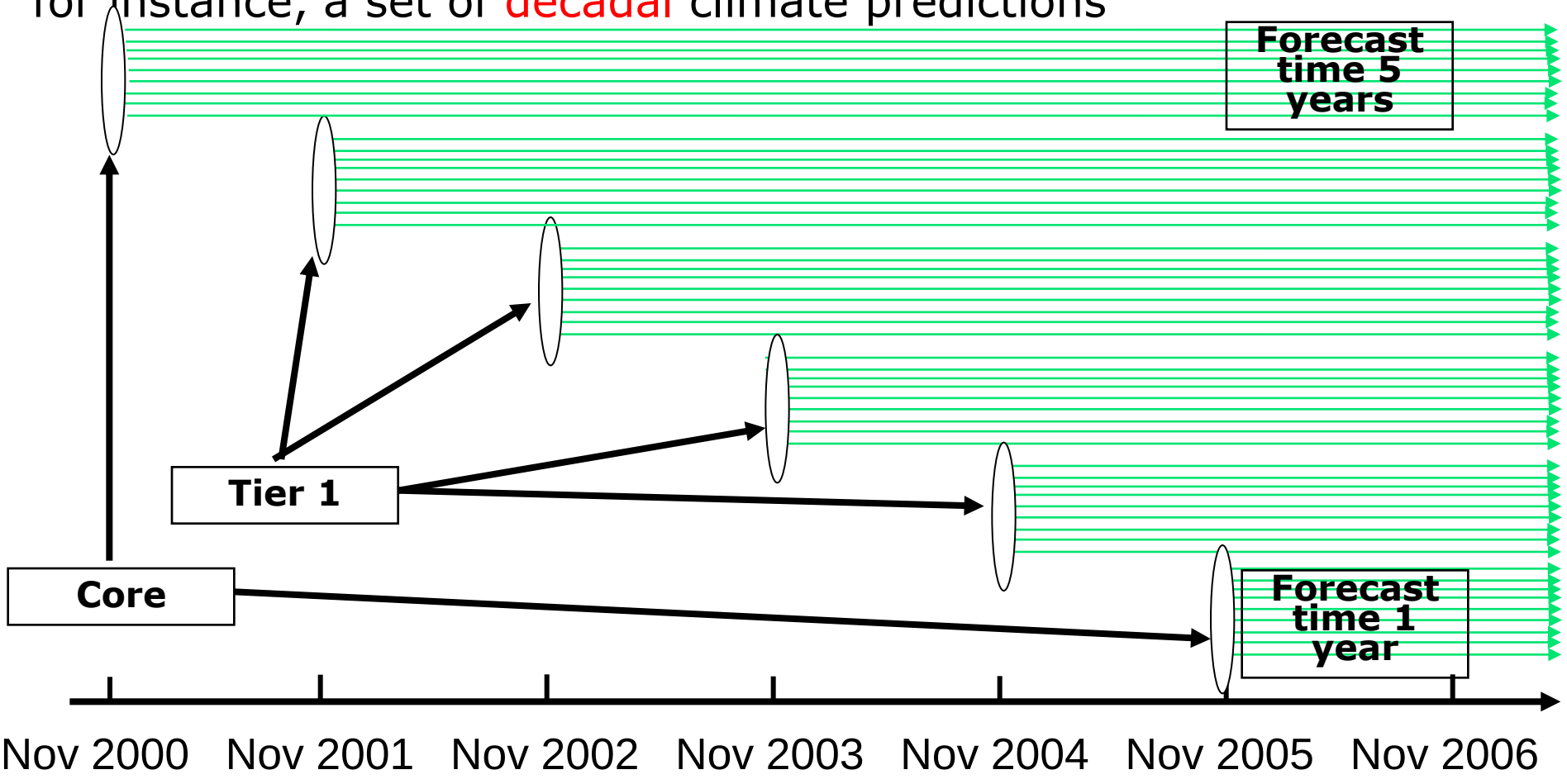
Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (sub-seasonal, seasonal and decadal) in the middle. Prediction involves initialization and systematic comparison with a simultaneous reference.



Meehl et al. (2009)

Climate predictions

Assume an ensemble forecast system with an initialized ESM to perform, for instance, a set of decadal climate predictions



Predictions are also made with empirical forecast systems to be used as benchmarks and to detect untapped sources of predictability.

Some open fronts in climate prediction

- Work on initialisation: initial conditions for all components (including better ocean), better ensemble generation, etc. Link to observational and reanalysis efforts.
- Model improvement: leverage knowledge and resources from modelling at other time scales, drift reduction. More efficient codes and adequate computing resources.
- Calibration and combination: empirical prediction (better use of current benchmarks), local knowledge.
- Forecast quality assessment: scores closer to the user, reliability as a main target, process-based verification.
- Improving many processes: sea ice, projections of volcanic and anthropogenic aerosols, vegetation and land, …
- More sensitivity to the users' needs: going beyond downscaling, better documentation (e.g. use the IPCC language), demonstration of value and outreach.

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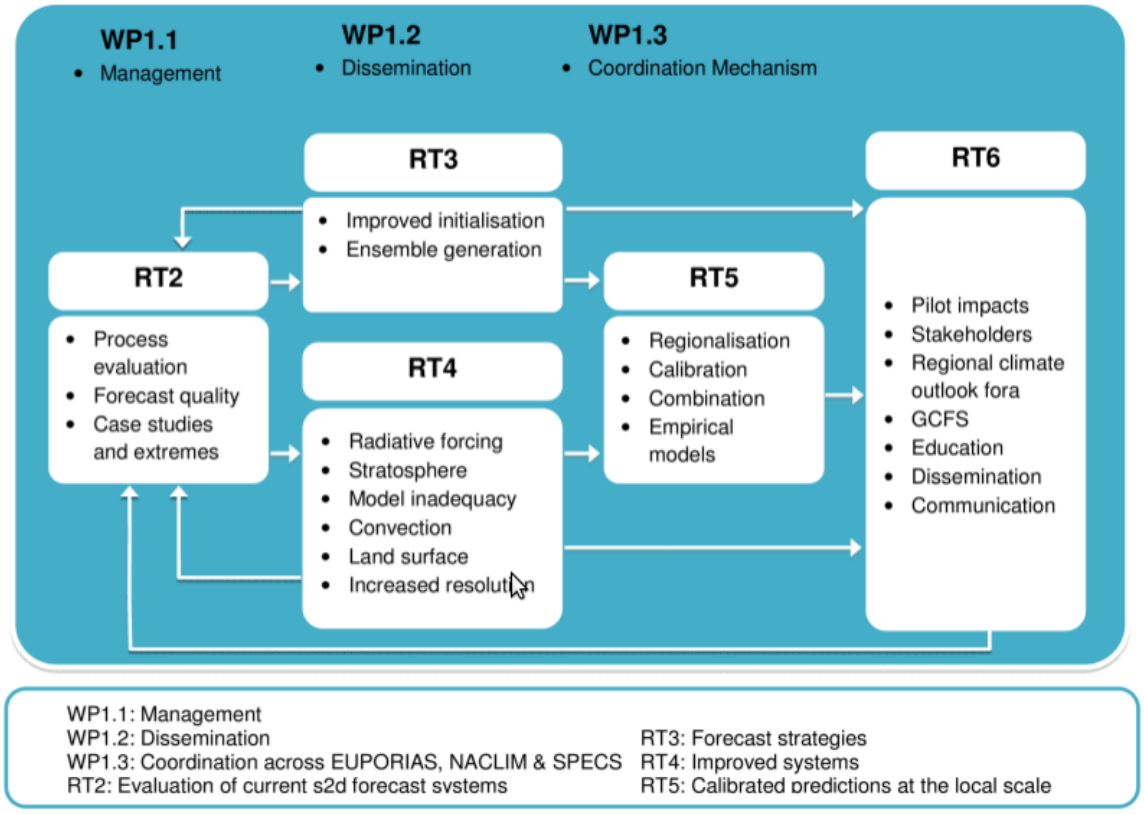
SPECS FP7

SPECS will deliver *a new generation of European climate forecast systems, including initialised Earth System Models (ESMs) and efficient regionalisation tools to produce quasi-operational and actionable local climate information over land at seasonal-to-decadal time scales with improved forecast quality and a focus on extreme climate events, and provide an enhanced communication protocol and services to satisfy the climate information needs of a wide range of public and private stakeholders*.

Forecast System	Project Partners
CNRM-CM5	CNRM, CERFACS
EC-Earth	KNMI, SMHI, IC3, ENEA
IFS/NEMO	ECMWF, UOXF
IPSL-CM5	CNRS
MPI-ESM	MPG, UniHH
UM	UKMET

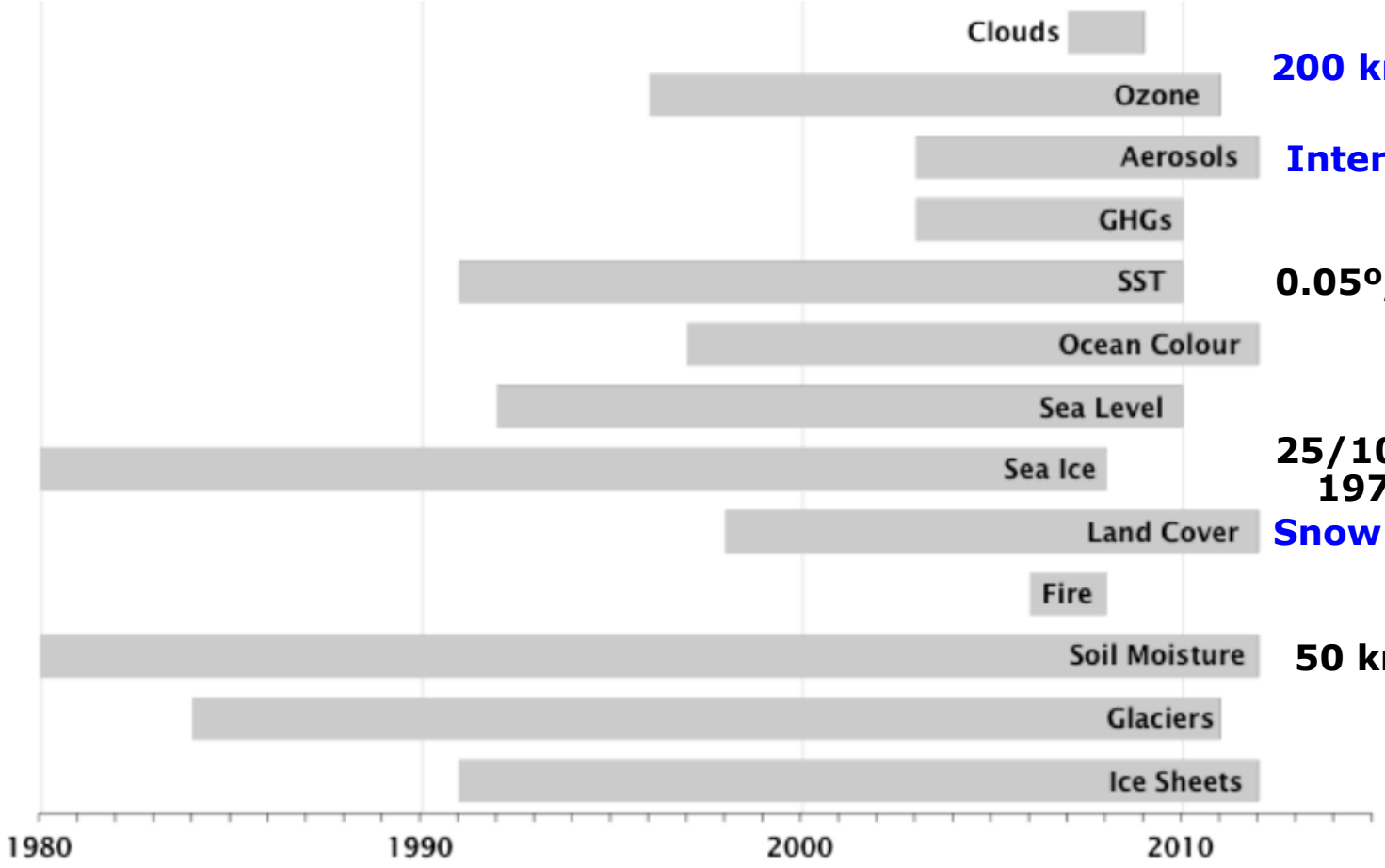


WCRP Grand Challenge #1

- Can we provide skilful regional climate predictions at seasonal to decadal time scales and reliable and actionable long term regional climate change projections?
- Four scientific frontiers:
  - **Frontier 1: Intraseasonal and seasonal predictability and prediction**. Identify and understand phenomena that offer some degree of intra-seasonal to inter-annual predictability, and skilfully predict these
  - **Frontier 2: Decadal variability, predictability and prediction**. Identify and understand phenomena that offer some degree of decadal predictability and skilfully predict these climate fluctuations and trends
  - **Frontier 3: Reliability and value of long term regional climate change projections**. Provide reliable regional climate projections for the 21st century and beyond for use in Impact, Adaptation and Vulnerability (IAV) studies as a basis for response strategies to climate change
  - **Frontier 4: Definition of usefulness: informing the risk management and decision making space**. Provide information that constitutes a solid and targeted basis for decision making concerning risk management and response, also through active and two-way involvement with stakeholders

CCI datasets for climate prediction

Satellite data useful for initialisation, model validation, verification and impact-model development. Long time series AND uncertainty estimates absolutely fundamental for adequate use.



200 km profiles, ~5 days, short periods

Interesting but too short

0.05º, daily, 1991-2010

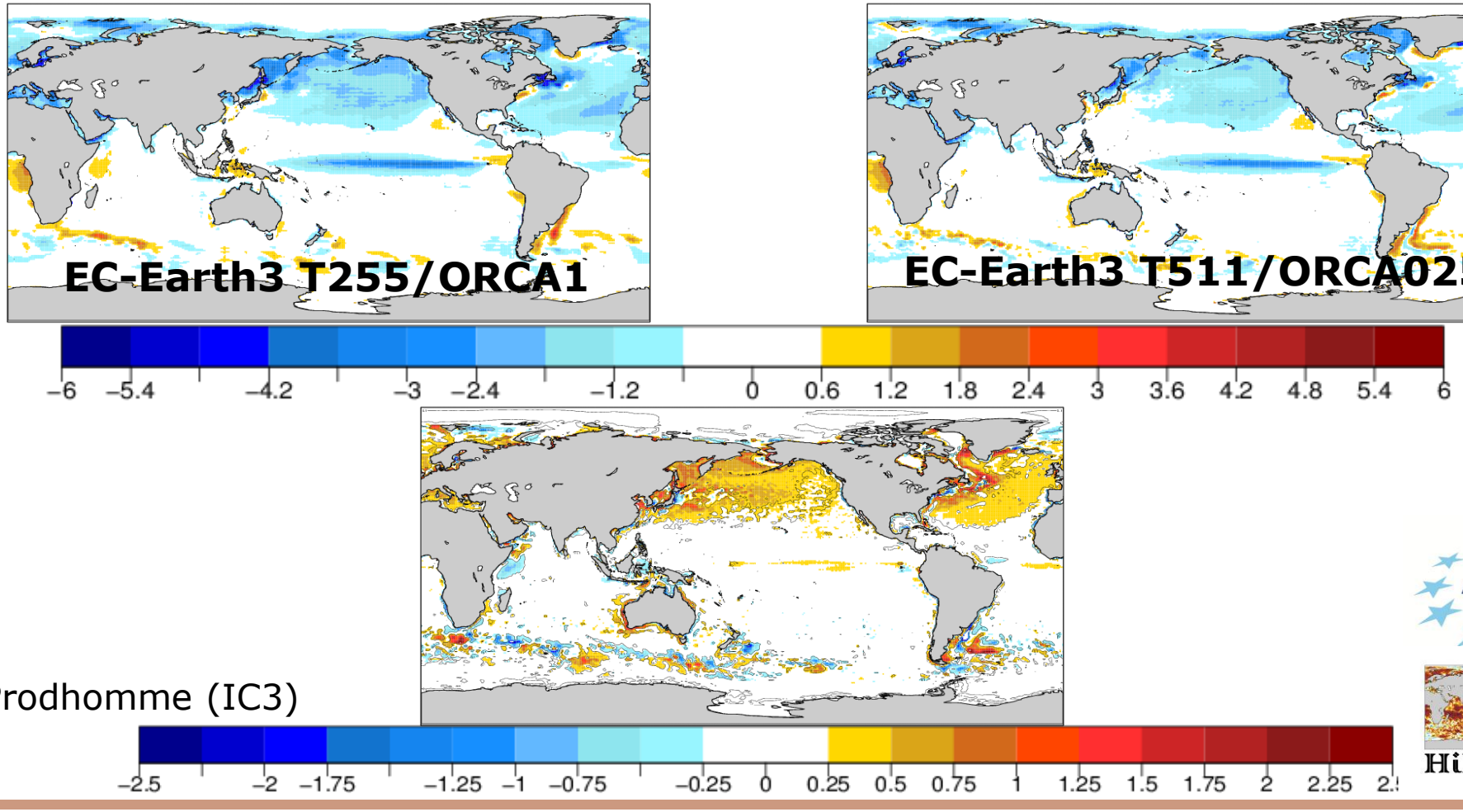
25/100 km, daily/monthly, 1979-2008/1993-2012

Snow and NDVI, 1998-2012

50 km, daily, 1979-2012

Increase in resolution: mean climate

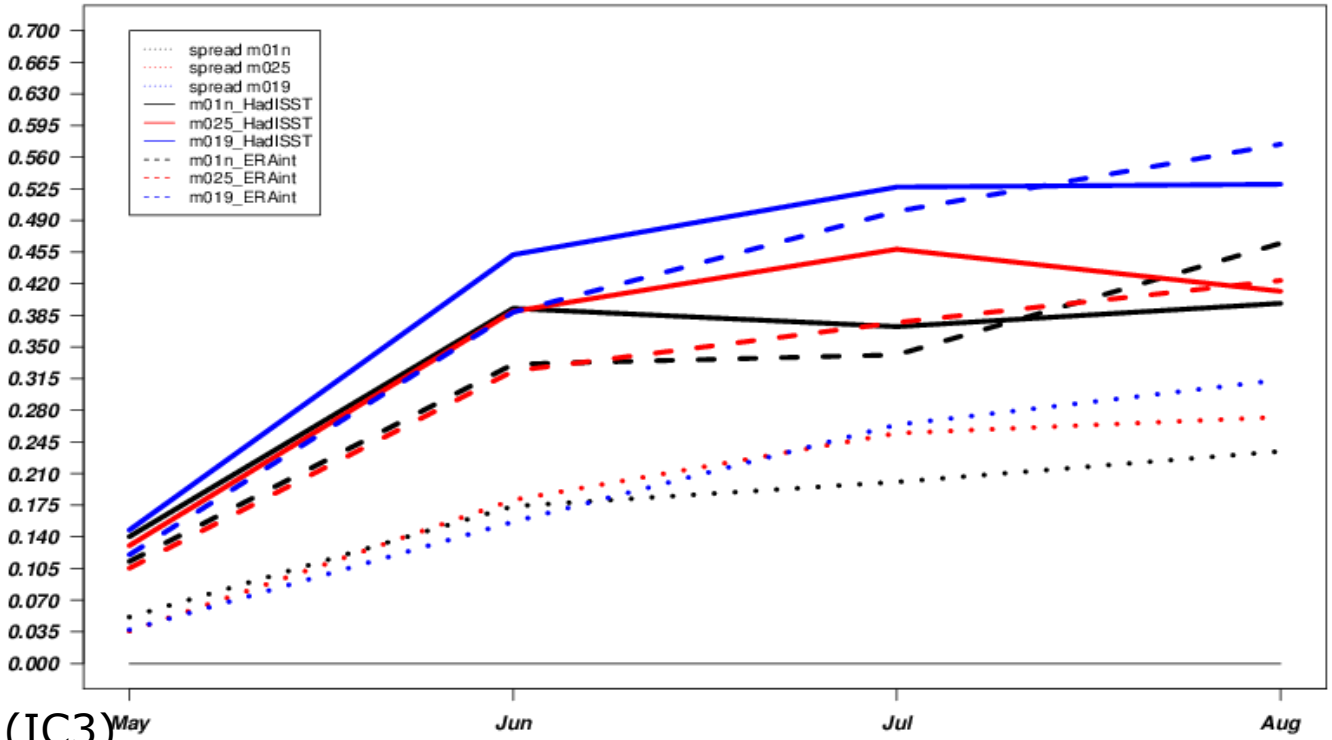
Mean SST (K) systematic error versus ERAInt for JJA one-month lead predictions of EC-Earth3 T255/ORCA1 and T511/ORCA025. May start dates over 1993-2009 using ERA-Interim and GLORYS initial conditions.



C. Prodhomme (IC3)

Increase in resolution: ENSO skill

RMSE and spread of Niño3.4 SST (versus HadISST-solid and ERAInt-dashed) from four-month EC-Earth3 simulations: **T255/ORCA1**, **T255/ORCA025** and **T511/ORCA025**. May start dates over 1993-2009 using ERA-Interim and GLORYS initial conditions and ten-member ensembles.

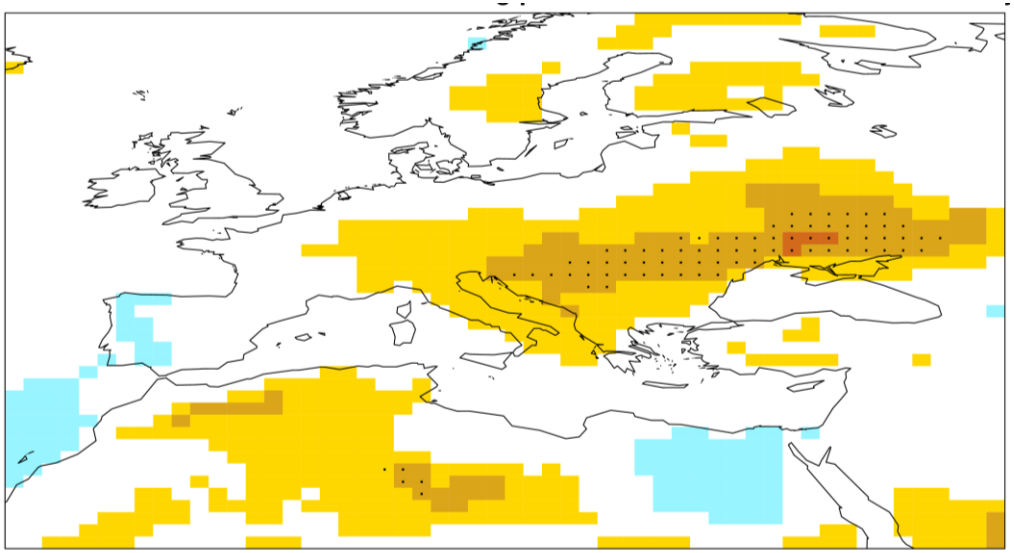


C. Prodhomme (IC3)

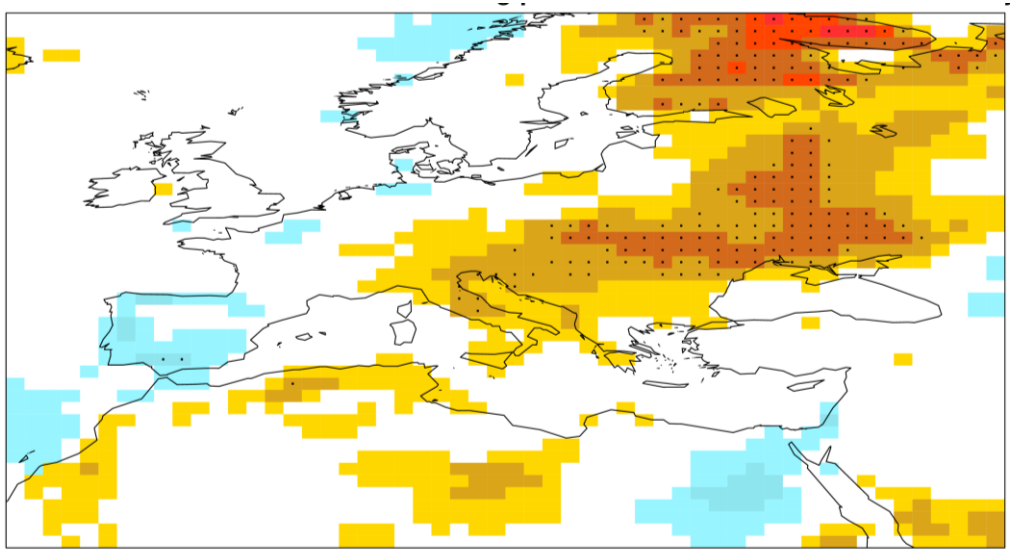
Impact of initialisation: Land surface

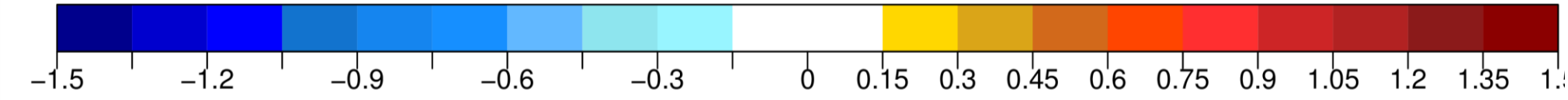
Difference in the correlation of the ensemble-mean near-surface temperature from two experiments, one using a realistic and another a climatological land-surface initialisation. Results for EC-Earth2.3 started every May over 1979-2010 with ERAInt and ORAS4 initial conditions and a sea-ice reconstruction.

Difference for monthly mean T



Difference for monthly mean daily Tmax





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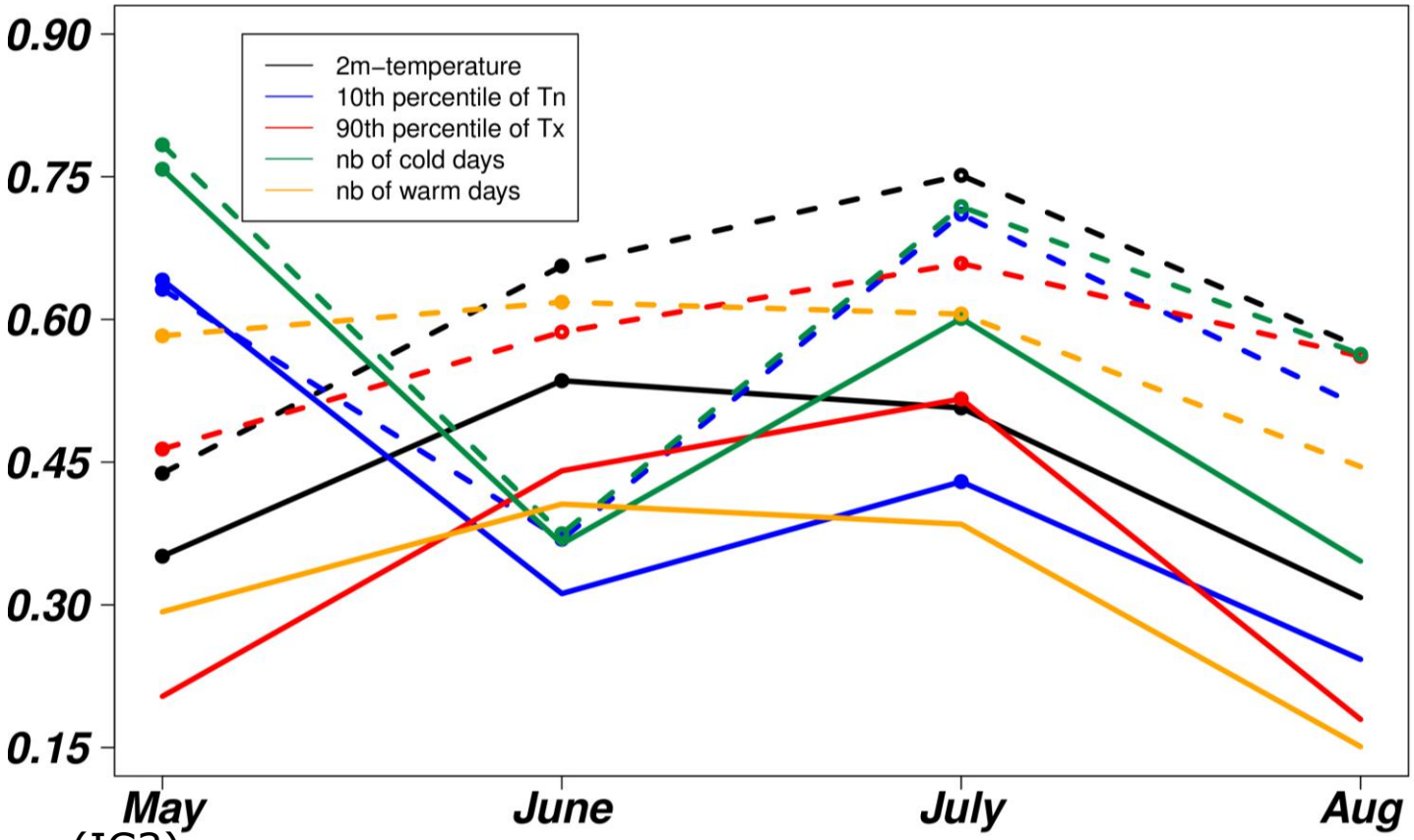
Impact of initialisation: Land surface

Correlation of the ensemble-mean for several temperature variables from experiments with a realistic (dashed) and a climatological (solid) land-surface initialisation. Results for EC-Earth2.3 started in May with initial conditions from ERAInt, ORAS4 and a sea-ice reconstruction over 1979-2010.



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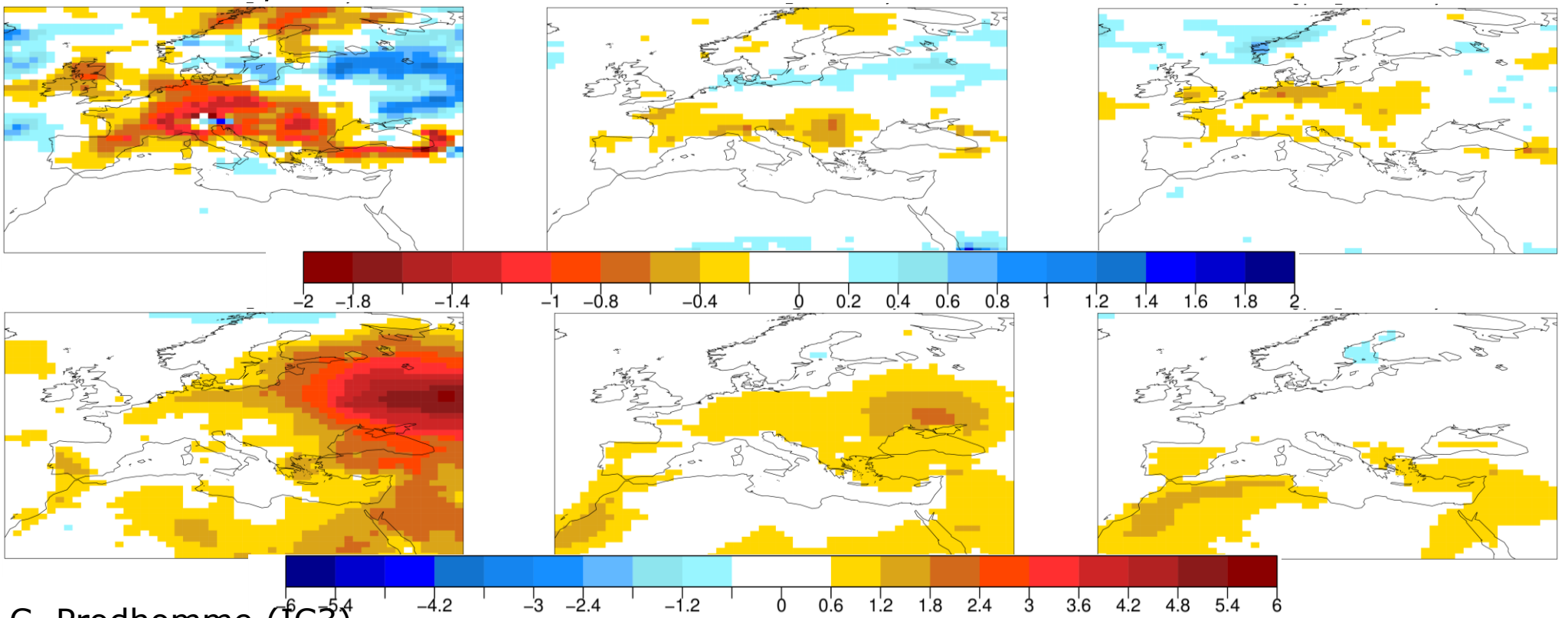
Impact of initialisation: Land surface

JJA precipitation (mm/day) in 2003 (top row) and near-surface temperature (K) in 2010 (bottom row) anomalies from ERAInt (left) and experiments with realistic (centre) and climatological (right) land-surface initialisation. Results for EC-Earth2.3 started in May with initial conditions from ERAInt, ORAS4 and a sea-ice reconstruction over 1979-2010.



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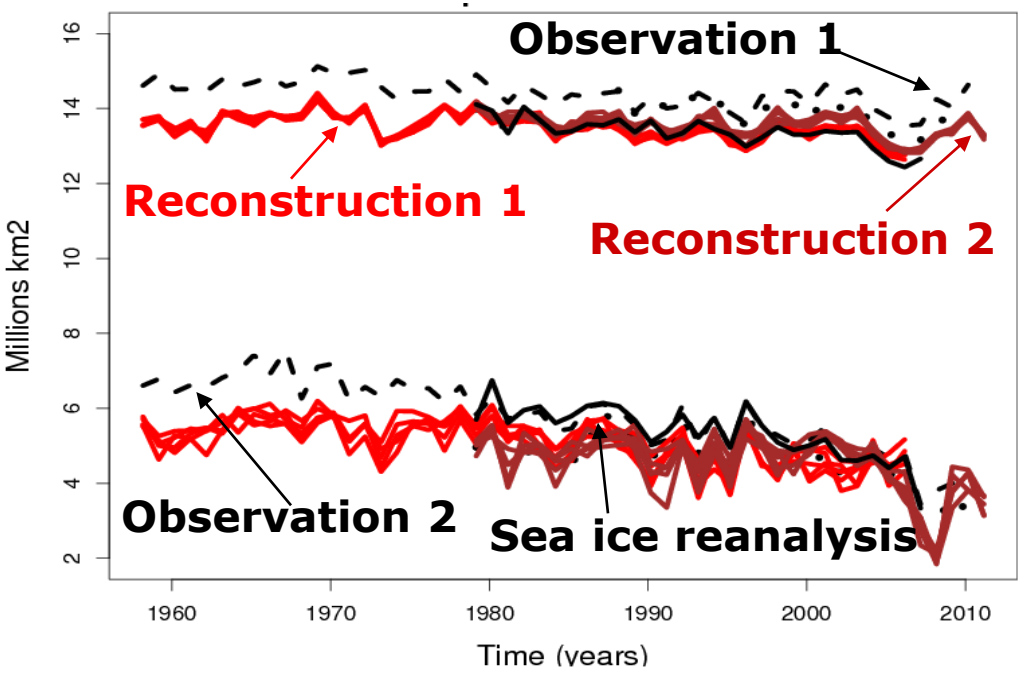
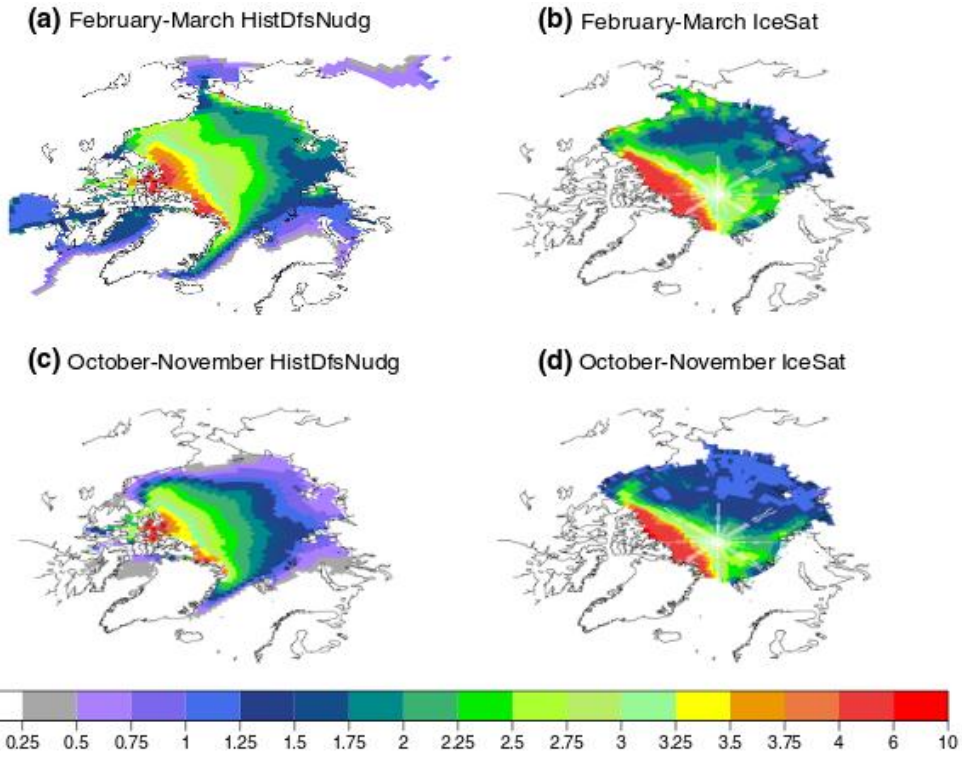
Initial conditions: sea-ice reconstructions

Sea ice simulation constrained by ocean and atmosphere observational data to generate sea-ice initial conditions.

Arctic sea-ice area
March and September



sea-ice thickness
for three years (2003-2006)

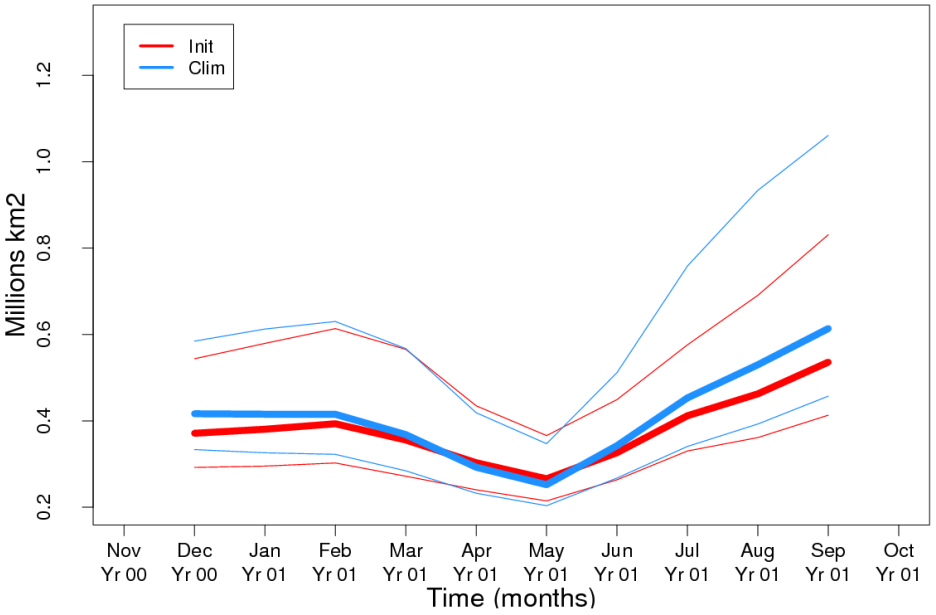


Guemas et al. (2014)

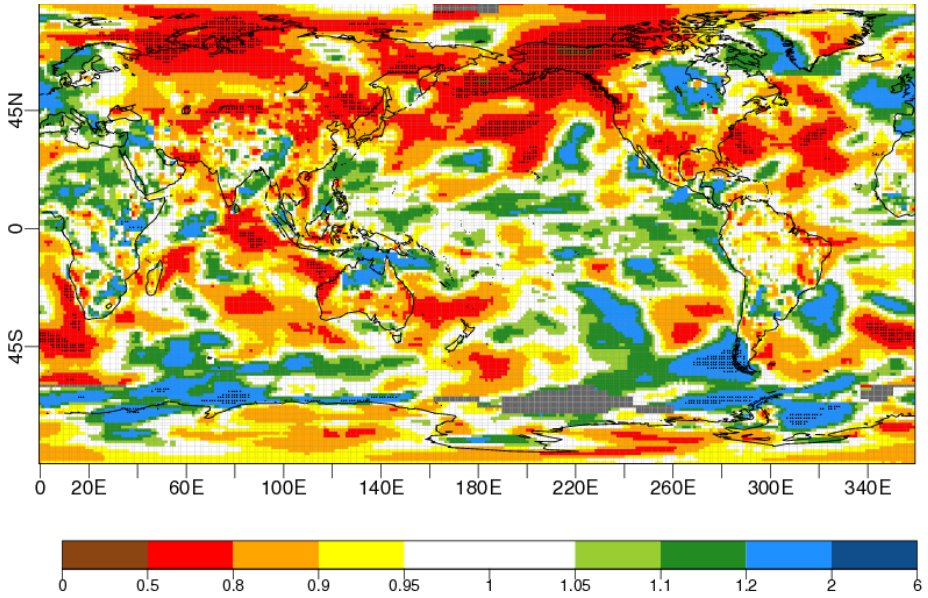
Impact of initialisation: sea ice

Predictions with EC-Earth2.3 started every November over 1979-2010 with ERAInt and ORAS4 initial conditions, and a sea-ice reconstruction. Two sets, one initialised with realistic and another one with climatological sea-ice initial conditions. Substantial reduction of temperature RMSE in the northern high latitudes when using realistic sea-ice initialisation.

RMSE Arctic sea-ice area



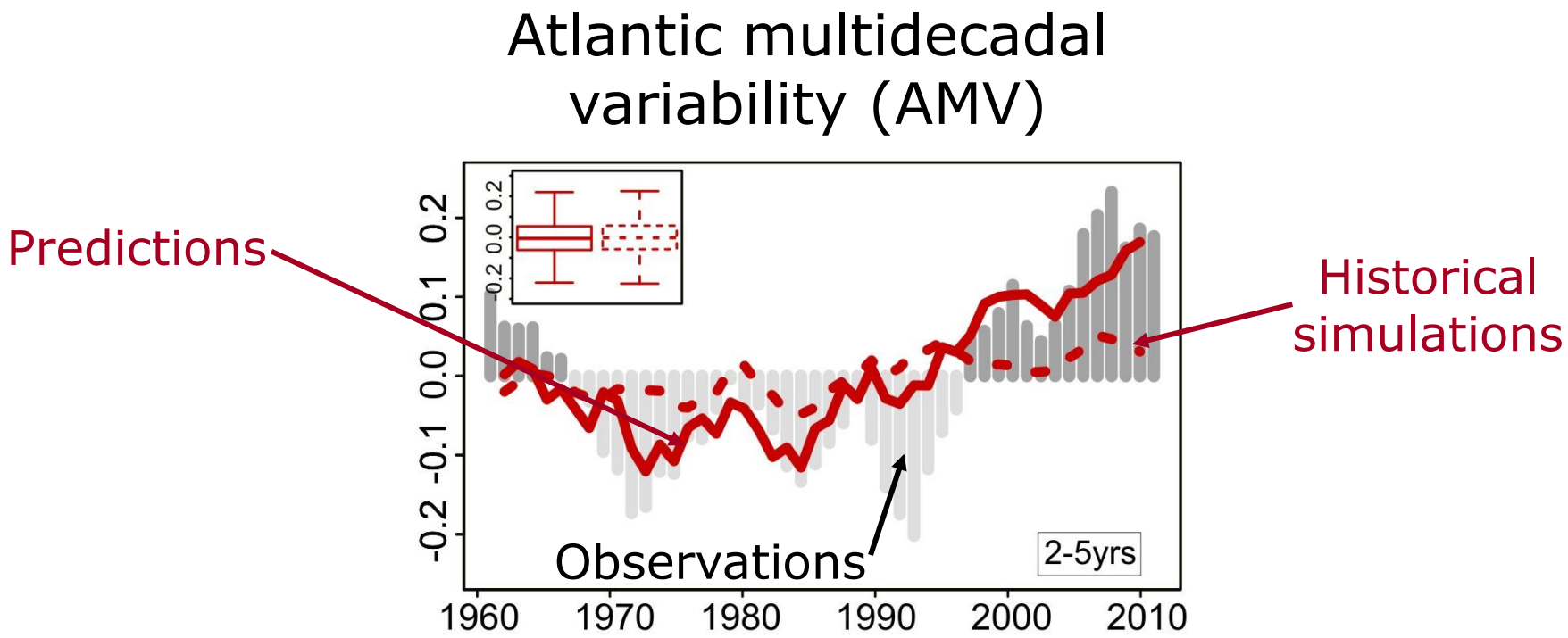
Ratio RMSE Init/Clim hindcasts 2-metre temperature (months 2-4)



Guemas et al. (2014)

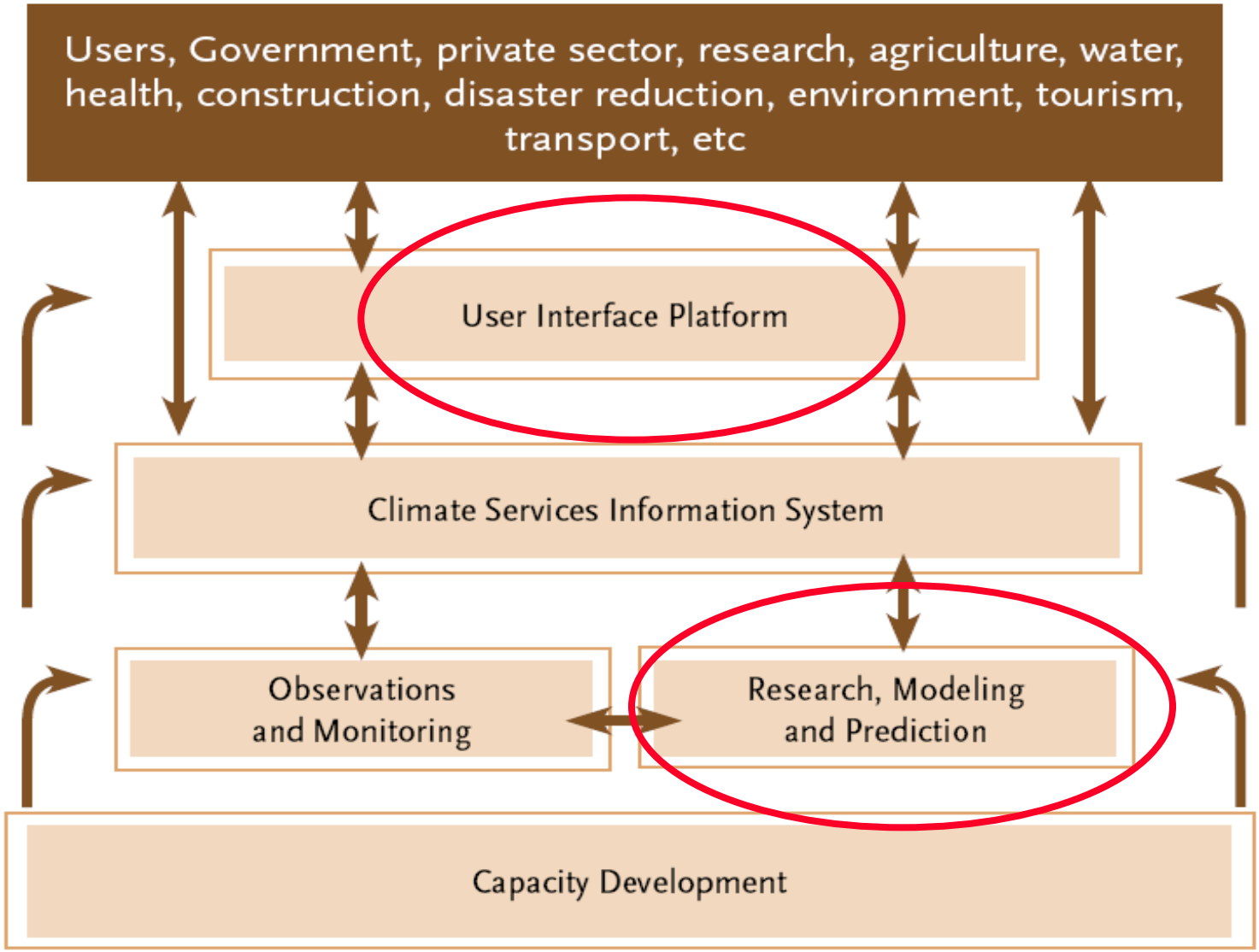
Decadal prediction: long samples

AMV for CMIP5 decadal predictions and historical simulations, plus ERSST3b for forecast years 2-5. **The initialised experiments reproduce the AMV variability and suggest that initialisation corrects the forced model response and phases in aspects of the internal variability.**



Doblas-Reyes et al. (2013)

Global framework on climate services



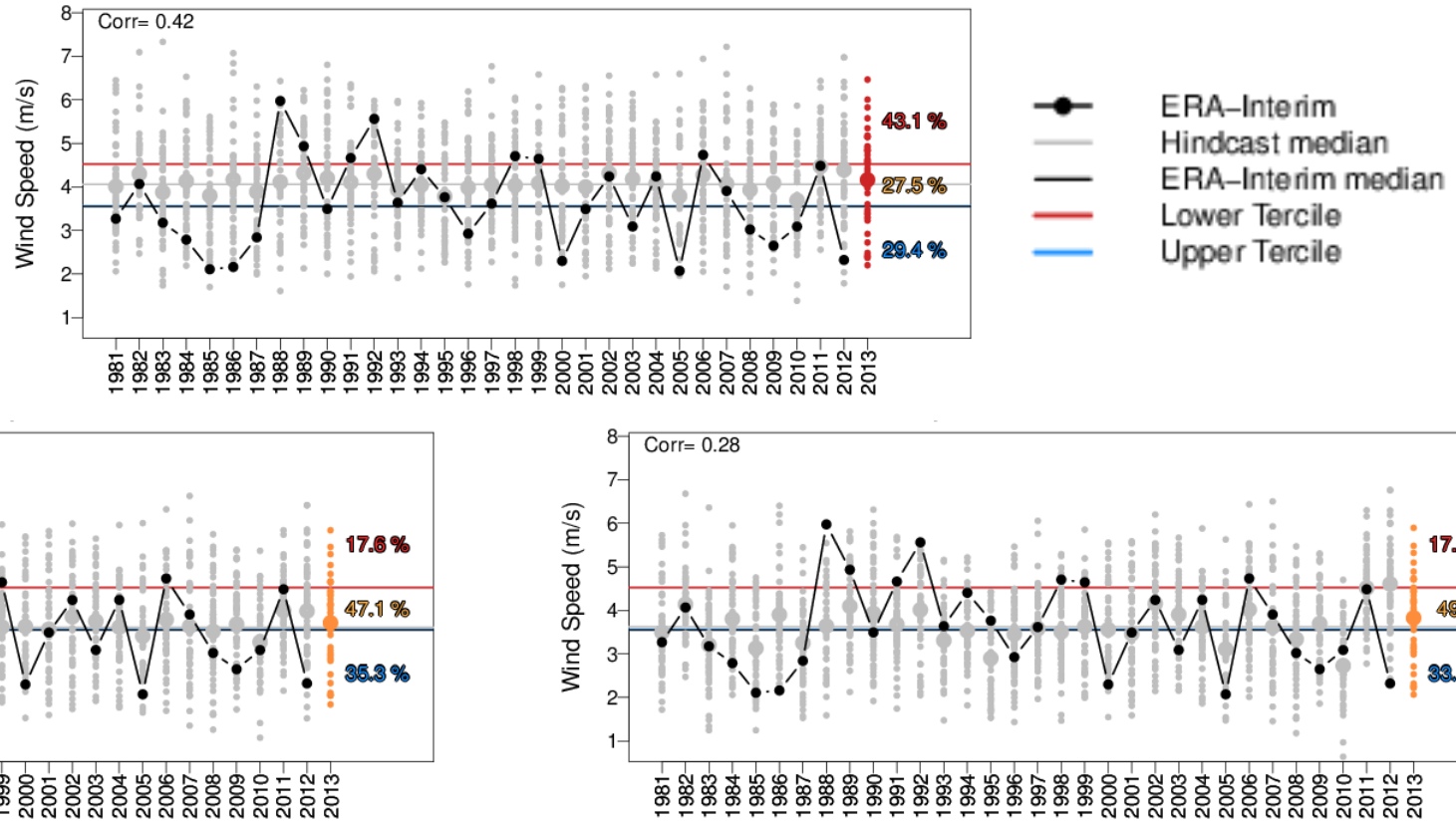
EUPORIAS

- EUPORIAS intends to improve our ability to maximise the societal benefit of climate prediction technologies.
- The project wants to develop a few fully working prototypes of climate services addressing the need of specific users.
- The time horizon is set between a month and a year ahead with the aim of extending it towards the more challenging decadal scale.
- This will increase the resilience of European society to climate change by demonstrating how climate information becomes usable by decision makers in different sectors.
- SPECS and EUPORIAS are part of ECOMS.

EUPORIAS

Bias correction and calibration

Bias correction and calibration have different effects. ECMWF S4 predictions of 10 m wind speed over the North Sea for DJF starting in November. Raw output (top), bias corrected (simple scaling, left) and ensemble calibration (right). One-year-out cross-validation applied.



V. Torralba (IC3)

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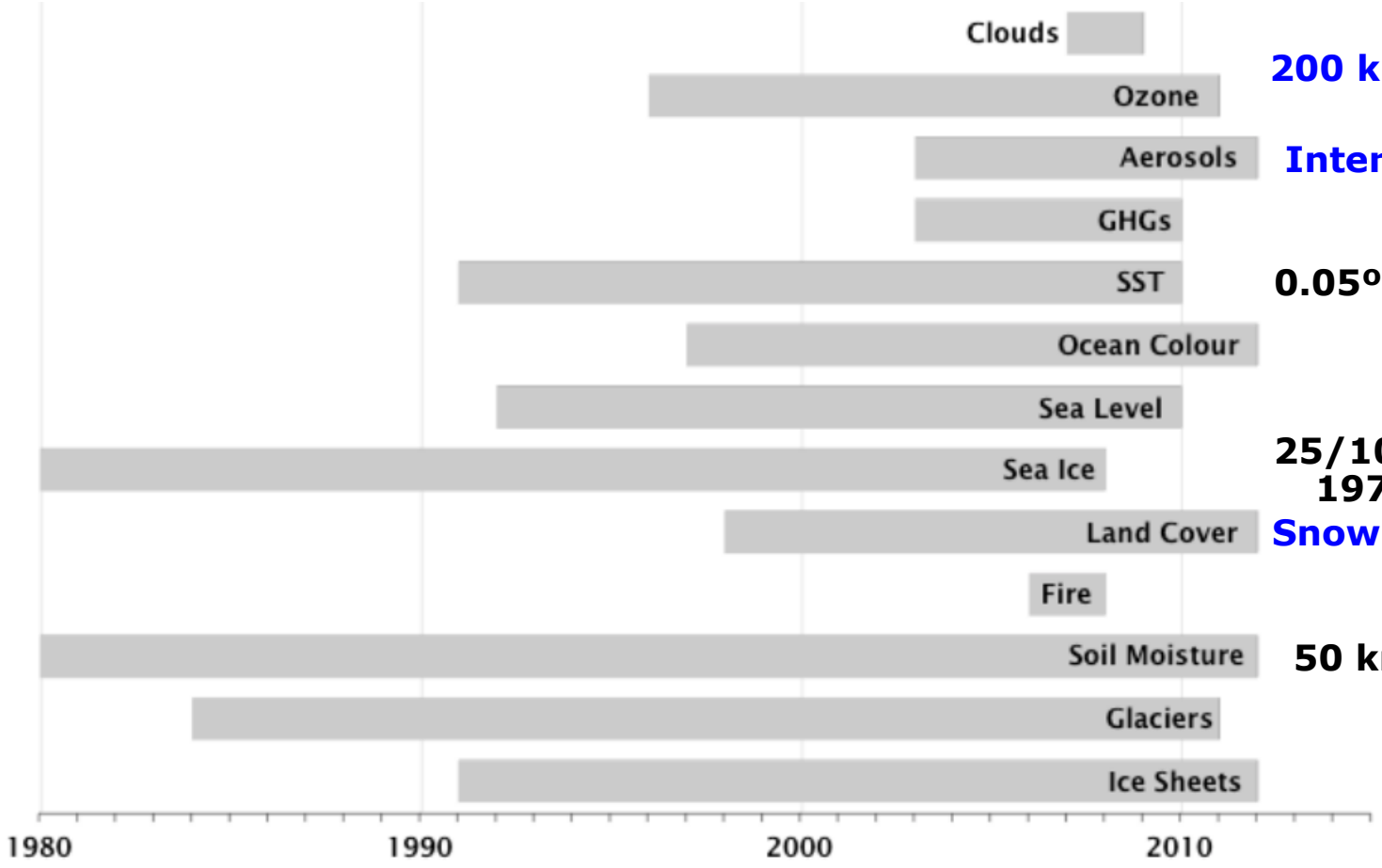

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